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AN INTERNATIONAL MEETING.

AT the recent meeting of the Council of the British Medical Association it was announced that the Section of Anæsthetics at Nottingham next summer will take the form of an international gathering, the Associated Anæsthetists of the United States and Canada having agreed to make it the occasion of their own annual assemblage. The President and Vice-President of the Section will be Drs. Samuel Johnston and F. H. McMechan respectively. Dr. Johnston is attached to the Montreal General Hospital, and, among other activities, has been for several years a member of the Research Committee of the International Research Society. Dr. McMechan is the well-known Secretary-General of the Associated Anæsthetists of the United States and Canada, as well as Editor of *Current Researches in Anæsthesia and Analgesia* and the Anæsthetic Supplement of the *American Journal of Surgery*.

It is mainly through the efforts of Dr. McMechan that we are to have this international gathering, and the thanks of the anæsthetic world generally are due to this intrepid and indefatigable worker, who does not rest content to bring together in this inaugural gathering English-speaking colleagues, but is making every effort to induce leading Continental anæsthetists to join in, what might well be termed, the first All-World Congress of Anæsthetists.

It is needless to say that anæsthetists on this side will embrace the opportunity to welcome their brother workers from abroad, and will leave no stone unturned to mark the occasion in a worthy manner.

THE EVALUATION OF SURGICAL RISKS.

FROM time to time ingenious minds have endeavoured to formulate a test which, in the guise of some formula, the anæsthetist might apply to assess a surgical risk. It would, indeed, make the task a comparatively easy one if, by some sort of penny-in-the-slot arrangement, it was possible to say beforehand that any particular case will stand the anæsthesia or not stand it; in a word, that the risk is a good one or a bad one. What more can be done by the careful anæsthetist in addition to his blood-pressure reading, and chest and urine examinations? What else of any value remains to help him evaluate a given risk? Are there available formulæ which make it possible to ascertain in advance of operation the amount of hazard he is facing? Numerous efforts have been made to establish these much-desired indices (F. H. McMechan, *Can. Med. Assn. Jnl.*, Dec. 1925). Some are dependent on blood-pressure readings alone, while others are respiratory or cardio-respiratory in character.

Of the respiratory, the best known is the breath-holding test, used during the late war in the selection of candidates for the French Aviation Service. Yandell Henderson gives the following directions for its application:—(1) Sit quietly for five minutes. (2) Take a full, but not too deep, breath. (3) Hold it with mouth and nostrils closed. (4) Note time breath is held in seconds; about forty-five seconds are said to indicate the normal.

In Moot's Index for Operability the rule is to divide the pulse-pressure by the diastolic pressure, thus getting the pressure-ratio per cent. Any case between 25 per cent. and 75 per cent. is probably operable. Outside this range lies danger.

A more elaborate Shock Index is that of Froes and Declairfayt, simplified somewhat by the former, who multiplies the product by the hæmoglobin percentage multiplied by the figure representing the hundred thousands of erythrocytes. Thus, if we take a systolic pressure of 170 mm., erythrocytes

3,600,000 and hæmoglobin 67 per cent. we have:— $\frac{170 \times 100}{36 \times 67} = \frac{17000}{2412} = 7$ plus, which is said to be the limit of safety.

The so-called Energy Index is found by adding the systolic and diastolic pressures and multiplying the result by the pulse-rate. The range of normality extends from 12,000 to 18,000.

Beaumont Cornell's test for undisclosed nephritics is an examination of the character of the response to exercise. In these cases the respiratory and pulse-rate both rise abruptly after exercise, but, although the latter comes back to normal almost at once, the respiratory does so only after seven or eight minutes.

In Vagotonia and Sympathicotonia the McIntyre test is made by attaching the blood-pressure apparatus to the arm and setting it to record the systolic pressure. The patient then takes a deep inspiration and holds the breath for thirty seconds, the blood-pressure changes being noted at five-second intervals. Vagotonics show a serious drop in the systolic pressure.

H. E. Ruth, of Philadelphia, has recently applied these various tests in several hundred operations with results that each was found to possess distinctive evaluating possibilities.

Dr. McMechan does well to remind anæsthetists that efforts to work out this type of scientific formula have already passed into the realms of practicability.

CARBON DIOXIDE IN ANÆSTHESIA.

By S. R. Wilson, M.B., M.Sc., F.R.C.S.E.,
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DURING the last twenty years striking advances have been made in the study of the regulation of the respiratory mechanism. It is true that Galen in the 2nd century (A.D.) noted that section of the spinal cord at the level of the second vertebra produced death, but it was not until 1851 that Flourens definitely described the Respiratory Centre or "Nœud Vital" in the floor of the fourth ventricle just above the Calamus Scriptorius. For many years after this attention was chiefly centred upon the nervous control of respiration, but during the present century physiological investigations have largely been devoted to the study of the chemical control of respiration, and results of incalculable value, both in the explanation of phenomena during anæsthesia, and in the improvement of anæsthetic practice, have been obtained. It is now generally agreed that the chemical control of the Respiratory Centre is more important than the nervous factor, for respiration still continues after section of all afferent nerves to the centre, but ceases when the circulation through this area is stopped. It can readily be experimentally demonstrated that injection of carbon dioxide, dissolved in blood, into the carotid artery produces almost at once a marked deepening of the respirations, and a similar result is obtained if the gas be inhaled into the lungs in the human subject. Variations in the supply of oxygen have, however, no effect until a stage is reached when oxygen lack begins to show itself, which occurs when the oxygen percentage in the atmosphere falls below thirteen. Injection of lactic acid and warming of the carotid blood also produce intensification of the respiratory movements. The action of carbon dioxide on the centre is by far the most delicate, and possibly specific, entitling us to regard CO_2 as a definite respiratory hormone.

Whether the condition of the arterial blood or the special metabolism of the respiratory centre is the essential factor is as yet undecided, but from a practical point of view it is fortunately immaterial, for an increase in the CO_2 tension of the arterial blood produces a deepening of respiration, whether the action is direct or whether the increase of CO_2 tension of the blood delays the removal of the carbon dioxide produced by the centre's own metabolism.

The practical utilization of these principles in the interpretation of respiratory phenomena and their bearings on anæsthetic practice can now be briefly considered.

Every student of general anæsthesia is familiar with the so-called "automatic breathing," but how many realize its true significance, or that the whole safety and development of general anæsthesia depends upon this specific respiratory hormone. Pharmacologists tell us that the various narcotic and anæsthetic drugs depress the nerve centres in a descending sequence, and yet the action of the anæsthetic is continued until lower spinal centres, such as those which control the knee-jerk, are put out of action. The respiratory reflex action is similarly dulled, but, thanks to carbon dioxide, the activity of the respiratory centre is still preserved, and safeguards the patient when all reflexes are abolished. The so-called "automatic breathing" of anæsthesia is analogous to the physiological experiment of section of all afferent nerves to the respiratory centre, and the respiration becomes slow, deep and regular (unless anoxæmia simultaneously develops), the centre being now entirely under chemical control, all usual peripheral stimuli being cut off. In addition to this safeguard CO_2 supplies one with a delicate control over the induction, maintenance, and termination of anæsthesia, for the scientific development of which we are largely indebted to Professors Yandell Henderson and Haggard, whose valuable researches on this subject should be studied by every anæsthetist. The visit of Professor Henderson to this country, together with the lectures he has given, has served as a stimulus to this work in relation to anæsthesia, and a few practical observations by one who has for many years followed their work, and tried to put these principles into actual practice, may not be out of place at the present juncture.

The applications of this gas in anæsthesia are extremely numerous and varied, and, whilst in some instances utilization of the patient's own CO_2 may suffice, if one is to attain the maximum benefits it is advisable to have 5 per cent. of carbon dioxide added to one's oxygen cylinders. This presented an initial difficulty, but the writer succeeded in obtaining cylinders filled with this mixture nearly two years ago. It was thought that two gases having such different condensation points could not be blended, yet the satisfactory nature of the mixture can be verified by the physiological test, when intensification of breathing is readily observed. Further casual specimens taken at intervals and analyzed with a Haldane gas analysis apparatus have invariably yielded a mixture a point or two on either side of 5 per cent. CO_2. Formerly, when chloroform was extensively used for the induction stage of general anæsthesia, the patient was apt to pass into a somnolent state, associated with shallow breathing. Various devices, such as rubbing the lips, ribs, condyle of jaw, and even slapping of the face were not uncommonly resorted to. The effects produced are quite transient and insignificant unless the stimulation is severe enough to be painful, in which case struggling is often precipitated. Efficient regular breathing can easily be instituted if the nostrils be gently compressed so as to eliminate nasal breathing. This raises the partial pressure of the alveolar CO_2, and in consequence the CO_2 tension in the blood. If respiratory tracings be taken the constancy and effectiveness of the procedure is strikingly demonstrated. To the clinical observer the effect is equally pronounced. In the case of " open ether " the presence of the mask interferes with this procedure, but an exactly similar result is obtained by adopting a semi-open method (such as the three towel method) which conserves the carbon dioxide in the patient's expired air. Henderson has suggested that the CO_2 oxygen mixture might be used for this purpose, especially as Haggard states that the ether tension in the carotid blood becomes the same as that in alveolar air within a few seconds, and that in this way rapid deep ether anæsthesia might be produced. In actual practice the problem is not so simple, for during the induction stage the nervous control of the respiratory centre is still active, and the presentation of

strong ether vapour is resisted by the patient and produces undesirable reflex effects (coughing, retching, swallowing, and holding of the breath with accompanying cyanosis). It is true that if CO_2 be persevered with, respiration will eventually occur, but the procedure is analogous to the old-fashioned method of choking a patient with a closed ether inhaler, and is somewhat barbarous and apt to lead to undesirable accompaniments, such as excessive secretion and swallowing of mucus. Many years ago the writer experimented with rapid ether inductions, but, although the patient could be got deeply under in two to three minutes, adequate muscular relaxation did not occur any earlier than with more gradual methods. Ideal induction must still depend on judicious utilization of the patient's own carbon dioxide, combined with the practical skill of the administrator in coaxing the patient not to resist the presentation of a gradually increasing strength of ether vapour. At the end of the induction period, if the patient is not quite deep enough the CO_2 oxygen mixture bubbled through the ether bottle of a Shipway's appartaus will rapidly deepen the anæsthesia and produce effective relaxation. It is now generally recognized that the excessive ventilation of the open ether method leads to washing out of carbon dioxide and to the production of acapnia with its associated undesirable effects, and most anæsthetists adopt some method of conservation of carbon dioxide under these circumstances, either by covering up the open mask or by resorting to a certain amount of re-breathing with a closed bag. The limitation of oxygen consequent upon this is corrected by the delivery of Oxygen-ether mixture underneath the mask. Personally conducted analyses of the gases under a Schimmelbusch mask under these conditions revealed—

CO_2 6—8 per cent. Oxygen 23—28 per cent.

As far back as 1907 I noticed that the old Clover ether inhaler was a most effective methodof dealing with surgical shock, and christened the instrument "the Shock Absorber," and the work of Henderson and Haldane has disclosed the reason of its effectiveness. Apart from all theoretical considerations the value of re-breathing is strikingly evident clinically in cases of shock and severe hæmorrhage.

Another class of case in which the mixture is extremely

valuable is in upper abdominal surgery, especially in extensive operations on the bile-passages. Many factors combine to render the anæsthetist's task a difficult one. The presence of a metal bridge under the lower thorax fixes the chest in a partial inspiratory position, and prevents its full expansion. Observations were made with a Douglas bag with a view to testing the pulmonary ventilation under these conditions. A reduction of 30—40 per cent. in the output of the lungs was recorded, clearly demonstrating the serious embarrassment to breathing which this surgical posture produces. Further deep anæsthesia is required, and at such a depth respiration is almost entirely abdominal. The respiratory centre is rendered less sensitive by deep anæsthesia, and the traction exerted by the surgeon and his assistant embarrasses this sole respiratory movement. It is extremely difficult to get the anæsthetic into the patient, and inhibition of breathing is prone to occur. Under such conditions I have found the mixture invaluable, especially in combination with a Shipway ether bottle. Not infrequently stoppage of respiration occurs for a minute or two when the gall-bladder is pulled upon, although the circulation remains in good condition. If this inhibition takes place the mixture should be delivered directly into an oral tube in the patient's mouth. In the absence of the mixture a similar result is obtainable by blowing down a yard of rubber tubing inserted into the oral tube, and this is also a most effective method of conducting artificial respiration. I have christened it the Biblical Method as it is really a modern application of the method of mouth to mouth insufflation used by Elijah in restoring the widow's son to life (I. Kings, ch. 17, v. 21) and later by Elisha in raising from the dead the good Shunammite's son (2 Kings, ch. 4, v. 32—35). The latter description being much more detailed. We have also tested the procedure in animals overdosed with ether until respiration was definitely stopped for some time and a marked fall of blood pressure produced, and found it to be highly effective. Overdose in cases of rectal etherization can also be effectively combated by the above methods.

In nearly all the above instances the effects can to a large extent be obtained by accumulating the carbon dioxide in the patient's expired air, but there is one case in which the CO_2

oxygen mixture is of supreme advantage. I refer to the process of de-narcotization, in which case, if we try to utilize the patient's own carbon dioxide, we are also retaining the ether excreted in the breath and so neutralizing the process. All general anæsthetics are toxic agents in varying degrees and prone to produce undesirable after-effects on the patient. It is therefore advantageous to effect their elimination the moment their work is completed. Henderson and Haggard have investigated the rate of excretion of ether after general anæsthesia and provided us with accurate data on this subject. They found that half the total ether in the body was eliminated in the first half hour after the administration is stopped. Half the remainder is excreted during the next one to two hours, but complete elimination does not occur until one to two days. If it is possible to accelerate this process undesirable after-effects can be greatly reduced or completely avoided. Now, if 5—6 per cent. CO_2 be added to the oxygen pulmonary ventilation is increased two, three or four times. The writer has tested these experimental observations in actual clinical practice during the last two years with most gratifying results, both to himself and the patients concerned. The apparatus required consists of one's ordinary gas-bag with stopcock and face-piece. The gas-bag is connected by rubber tubing to a cylinder of oxygen containing 5—6 per cent. carbon dioxide. The cylinders are distinguished from ordinary oxygen cylinders by their having a white star painted on them just above the middle of the body. Observations were chiefly made on severe abdominal cases and cases which had exhibited bad after-effects in previous anæsthesias. The face-piece is applied when facile suture of the peritoneum is assured. In a few moments the breathing will become vigorous and blowing, and the corneal reflex will become brisk, even if it were completely absent at the commencement of the application. About the time of insertion of the last suture slight movement may occur, and the patient will usually open the eyes when ordered to do so before leaving the theatre, though they will have no conscious recollection of it. With returning consciousness morphine, if it has not been previously administered, may be given for post-operative pain. This drug, if injected before the anæsthetic is excreted, doubles the period of

elimination. The application can, if necessary, be continued after the patient has returned to bed, but actually it has not proved necessary. In the case of young children it has been thought desirable to avoid a valved system, and the mixture is delivered beneath an ordinary open mask devoid of anæsthetic. The chief benefits constantly observed are rapid recovery of the patient and absence of post-anæsthetic sickness. Prevention of shock, raising of lowered blood pressure, and steadying of the pulse. Lessening of gas pains and diminished liability to intestinal paresis. In this connection it should be remembered that diminished peristalsis after abdominal operations is largely due to draining off of carbon dioxide from the exposed viscera. The striking effect of CO_2 in causing intestinal contractions has been clearly demonstrated in animals, and the giving of the above mixture might with advantage be resorted to in cases of post-operative intestinal paresis. After-toxæmia is enormously reduced in acute septic abdominal cases. The liability to post-operative bronchitis and pneumonia is greatly diminished. In one instance a two stage operation was performed on a very unfavourable subject, naturally prone to a weak chest. The first stage consisted of colostomy, and was conducted by ordinary methods. The patient was fairly ill after the operation and developed a bad chest. The second stage was undertaken about a fortnight later with some trepidation. It consisted of perineal excision of the rectum, and lasted about one and three-quarter hours. De-narcotization was employed, and the patient made a good recovery free from shock and chest complications. Rapid elimination by this method is very valuable in dental cases requiring ether, as it ensures rapid recovery and speedy return of the patient home. Yandell Henderson has drawn attention to the efficiency of the procedure in cases of gas poisoning and acute alcoholic intoxication, and the services of anæsthetists might with advantage be requisitioned on these occasions, as possessing the necessary apparatus and experience in its use.

Finally, I would urge all anæsthetists to study and put to practical use this valuable respiratory hormone, which gives them delicate control over the period of anæsthesia and a means of eliminating many of its distressing after-effects.

CEREBRAL HÆMORRHAGE DURING LOCAL ANÆSTHESIA.

By W. J. McCardie,
Birmingham.

BY the courtesy of Mr. Seymour Jones, F.R.C.S., I am enabled to relate this case.

A lady, aged 54, had been treated for high blood-pressure and headache since 1918. She was operated upon in 1920, under a general anæsthetic, by Mr. Seymour Jones for enormous hyperplasia of the turbinates. Her blood-pressure was very high at that time, but she went through the operation well, and had no further trouble until March 24th, 1924, when Mr. Seymour Jones removed a small amount of hyperplasia from the left turbinate under local anæsthesia (cocaine hydrochlor. 15%, with a little adrenalin added). The nose was first sprayed with this solution, and then gently swabbed with it. The patient bore this operation very well. She was advised to come in on April 7th last to have a small polypus removed from the right nostril. She arrived in the consulting-room apparently in her usual health. While sitting in a chair her nostril was sprayed with the above-mentioned solution and was also gently swabbed over with it, when suddenly she complained of her arm becoming numb and of feeling very unwell. She was unable to swallow water, and collapsed on to the floor on her right side, and became unconscious. She was taken in this state to a Nursing Home, and died there a few hours later from cerebral hæmorrhage.

The patient was seen immediately after her collapse by Dr. Hardy, that is at 1.15 p.m., who found that she had right hemiplegia, the heart-beat being forcible and the pulse of high tension. At 4.30 she was still unconscious. Her cardiac apex was far out in the anterior axillary line and the cardiac sounds were loud and thrusting. The blood-pressure was 260/100. Lumbar puncture showed fluid mixed with blood.

Venesection was performed, but the breathing became bad, and gradually failed, the pulse being still very strong.

The patient on arrival was excited and upset because her car broke down and she had to come into Birmingham by 'bus, and was hurried and late for her appointment.

As to the action of the drugs used, Cushing tells us that in the earlier stages of poisoning by cocaine the heart is accelerated and the vessels much contracted. Thus the blood-pressure would be raised.

Ross, quoted by Bacher in *Progressive Medicine*, March 1925, from the *Annals of Otology, Rhinology and Laryngology*, 1923, 32, 4, says: "If adrenalin and cocaine are injected into a vein, the rise of the blood-pressure is more than the sum of the increases by the adrenalin and cocaine if injected separately, and at a considerable time apart. Cocaine seems to sensitize the sympathetic nervous system, so that the stimulation by adrenalin produces a much greater reaction. These facts point to a rise in blood-pressure due to drug action during a tonsillectomy under local anæsthesia. From the clinical side, there seems to be some doubt on this point. It is usually hard to feel the pulse when a toxic disturbance results from the use of novocaine and adrenalin, and the common conclusion is that the blood-pressure is low. Naturally with fainting and respiratory disturbances a low blood-pressure is expected."

Ross also found that dogs injected in the tonsillar region with adrenalin showed an increase of arterial pressure of only 8 per cent.; of 83 per cent. by the injection of cocaine alone; but of 223 per cent. by cocaine and adrenalin. Swabbing the throats of dogs with 20 per cent. cocaine produced an increase in arterial pressure of 16 per cent., and the injection of adrenalin closely following the swabbing with cocaine produced an increase in pressure of 137 per cent. The intracranial venous pressure was unaffected or lowered 7 per cent. by injection of adrenalin alone, but if the adrenalin injection was preceded by cocaine swabbing of the throat it was raised 193 per cent. "This enormous increase in venous pressure due to adrenalin and cocaine is more than twice as great as that taking place in the arterial system. This condition of affairs is very significant. Whenever the intracranial

venous pressure increases twice as much as the arterial pressure, there is sure to be intracranial circulatory stasis and a resulting asphyxia of the respiratory centre would increase respiration and give a feeling of smothering to the individual. The tests show that the rate of respiration was increased 100 per cent. by cocaine and adrenalin. A feeling of smothering is a common complaint where there is any considerable reaction from the use of cocaine. The failure of adrenalin and cocaine to produce any increase in respiration when following morphine and atropine is due to the action of morphine to reduce the sensitiveness of the respiratory centre. Asphyxia of the higher parts of the brain would lead first to a feeling of uneasiness and some degree of excitement, which would be quickly replaced by a feeling of faintness and dimness of vision. This is the common experience of the individual who suffers a reaction from the use of cocaine and adrenalin. The changes in the heart action caused by these reactions are of little importance. The slight slowing of the heart action with an increased amplitude of beat seem to be only compensatory changes."

Bacher remarks that measurements of blood-pressure taken before, during and after tonsillectomy under local anæsthesia indicate that efforts to prevent mishap from the use of local anæsthetics should not be directed towards increasing the blood-pressure but towards preventing a rise in it.

In this case these four factors of exertion, excitement, swabbing by cocaine and adrenalin would appear to have contributed to the disaster. It is difficult to differentiate between the importance of any of them, but seeing that the patient had had exactly the same procedure carried out on a previous occasion with no ill-effects it would seem that the first two factors, namely, exertion and excitement, were the more important.

INSANITY AND ANÆSTHESIA.

Dr. Gilbert Brown, of Adelaide, in *The Medical Journal of Australia* (Oct. 10, 1925), revives the, for many years, controversial subject of the relationship of certain post-operative insanities to anæsthesia. He supplements those already reported by two cases which came under his own observation.

GAS AND OXYGEN ANÆSTHESIA IN RELATION TO ITS SAFETY TO THE PATIENT.

By J. Ross Mackenzie, M.D.,

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RECENTLY gas and oxygen has come into some disrepute as an anæsthetic in major surgery, more especially in cases requiring a prolonged anæsthesia. Fatal accidents upon the operating table while under gas and oxygen have been recorded; but so far, no statement of the factor or factors at fault in the anæsthetic agent or its administration has been published. The safety of any anæsthetic includes the immediate risk upon the table and the remote risk after operation. In these notes I propose to deal only with the immediate safety of the patient. The concensus of expert anæsthetic opinion, both in America and in this country, has been that nitrous oxide and oxygen, with or without ether, is the safest type of general anæsthesia we have at our command for minor or major surgery. This statement must be qualified since the safety of gas and oxygen anæsthesia is circumscribed by several factors entering into its administration.

The first is the type of patient for which the anæsthetic is chosen.

Gas and oxygen is particularly well suited and safe to the patient whose vitality has been reduced by long illness, toxæmia or loss of blood, also patients who have suffered severe shock from duodenal or appendicular perforation, from strangulation or intussusception of bowel. Cases with reduced vitality or suffering from shock are very susceptible to gas and oxygen anæsthesia. In strong contrast is the robust man accustomed to an outdoor life, alcohol and tobacco, who, having recovered

from a recent attack of appendicitis, comes to the operation table for appendicectomy, or the patient with emphysema, who comes with a strangulated hernia. In these cases a large proportion of oxygen is required to prevent asphyxia. The oxygen stimulates the existing tendency to excitement and prevents a sufficient concentration of nitrous oxide to anæsthetize the patient, while the addition of ether excites cough and respiratory spasm, and chloroform is always dangerous with a closed apparatus. Such cases would be ill-considered risks for gas and oxygen anæsthesia.

The second is that the co-operation of the surgeon is essential.

With gas and oxygen the surgeon must be interested in the benefits that accrue to his patient and sympathetic to the difficulties of its administration. He must frankly recognize the limitations of the anæsthesia and be prepared to act accordingly; otherwise it will be better for the patient and safer that gas and oxygen should not be the anæsthetic agent. The anæsthetist, on his part, should recognize that surgeons have been accustomed to anæsthesia with muscular relaxation by means of chloroform or ether, and they do not always find it easy to adapt themselves to the changed conditions which gas and oxygen anæsthesia, supplemented by ether, presents in, for example, an exploratory laparotomy or in cholecystectomy.

There are two things which should be done by the surgeon to enhance the efforts of the anæsthetist with gas and oxygen. The first is local infiltration of the operation area and blocking of the adjacent nerves, with ¼ per cent. or ½ per cent. novocaine. The second is gentle manipulation of the organs and tissues with refined traction and retraction. These are valuable adjuncts to any type of general anæsthesia, but practically essential to good and safe gas and oxygen anæsthesia.

The third is the actual administration.

Regarding safety, the Anæsthetics Committee of the British Medical Association in 1900 reported "that by far the most important factor in the safe administration of anæsthetics is the experience which has been acquired by the administrator." The report continues: "In many cases the anæsthetisation completely transcends the operation in

gravity and importance, and to ensure success, particularly in these cases, it is absolutely essential that an anæsthetist of large experience should conduct the administration." This statement is particularly applicable to the safe administration of gas and oxygen to-day.

The following points are of great importance, and an intimate knowledge and experience of them is necessary in the administration :—

(1) The percentage of nitrous oxide required to produce anæsthesia, with a sufficient percentage of oxygen to prevent asphyxia or anoxæmia.

(2) The toxic effects of nitrous oxide that may arise and progressively increase the more prolonged the anæsthesia.

(3) The anoxæmia which may arise from a deficient percentage of oxygen without necessarily producing clinical signs of asphyxia.

(4) The cerebral excitement and inefficient anæsthesia which may arise from excess of oxygen.

(5) The danger of loss of carbon dioxide by excessive respiration on the valves with consequent anoxæmia and apnœa.

(6) The risk of excessive rebreathing with hypercapnia and hyperpnœa.

The importance of these points vary largely in the individual case. The margin between safety and danger is much less with nitrous oxide and oxygen than with any other anæsthetic used for major operations, not on account of the anæsthetic agent itself, but rather on account of the exacting technique required in the administration. The anæsthetist must keep clearly in mind (*a*) that whatever be the anæsthetic action of nitrous oxide, it is not asphyxia. Asphyxia is a dangerous complication of gas and oxygen anæsthesia, and should never be allowed to arise in any degree. (*b*) That a theoretical standard of oxygen percentage has no foundation in practice, and may become a serious menace to the patient.

Gas and oxygen anæsthesia must be conducted on the merits and requirements of the individual patient. With nitrous oxide and oxygen alone at ordinary atmospheric

pressure, it is always difficult, and frequently impossible, to produce surgical anæsthesia with muscular relaxation without entering the danger zone of anoxæmia. Invaluable assistance will be derived from :—

(1) Infiltration of the operation area with novocaine.

(2) Positive ventilation of the lungs by keeping the gases in the gas bag at a pressure of 3—5 mm. Hg. In practice this means that the bag is distended with the mixed gases. The amount of gas in the blood depends upon its partial pressure in the pulmonary alveoli.

(3) Allowing the gases to pass over or through ether.

(4) Rebreathing the gases as well as the patient's carbon dioxide. The accumulated carbon dioxide will stimulate respiration, increase the intake of gases, conserve the patient's vitality and at least delay the onset of surgical shock.

The fourth is the nature of the operation.

Until recent years gas and oxygen anæsthesia has been used only for the big risk cases of major surgery. This fact explains the relatively high mortality upon the operating table, but to arraign the anæsthetic agent for this is to foster a fallacy and to produce most unreliable statistics. In the interest of the public, as well as the science of anæsthetics, there is urgent need that a distinction should be drawn between "Deaths under anæsthesia" and "Deaths due to anæsthesia." At present all deaths upon the operating table are taken to be anæsthetic deaths, and, so far as the Registrar-General's returns are concerned, are put down as anæsthetic deaths, even when it has been found post-mortem that the anæsthetic agent, as such, had nothing to do with the fatal issue. The nature of the operation for which gas and oxygen is used, whether it be dissection of neck glands or thoracoplasty, abdominal section, hysterectomy, or disarticulation at the hip joint, calls for less consideration the more expert the administration and the more thoroughly local infiltration analgesia or nerve blocking is done by the surgeon. In infants, children and adults the immediate, as well as the ultimate, risks are less with gas and oxygen and ether than with any other general anæsthetic agent, provided the conditions of safety are properly appreciated.

POST-ANÆSTHETIC TOXÆMIAS.

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Some reflections on Anæsthetic Toxæmias.

The instances already given are sufficient to emphasize the extreme gravity of anæsthetic toxæmias, and that they present dangers of considerably greater moment than the immediate risks of chloroform on the operating table. These dangers have by no means in the past been overlooked but are apt to be forgotten, or are prone to be limited to the classical form of delayed chloroform poisoning originally noted by the late Dr. Leonard Guthrie in 1894. It is the writer's contention that whilst this particular type is now well recognised, there are other undescribed forms more difficult of clinical recognition which are worth further study, especially in view of the improved methods of investigation of physiological function which have been introduced of late years. Clinical evidence of the extreme importance of the condition has already been given in the earlier part of this paper, and it is interesting to find independent surgical confirmation of these facts. For this purpose I shall refer to the operative results of Mr. A. H. Burgess in cases of acute appendicitis. In the *British Med. Journal*, July 13, 1907, he brings forward a list of 47 cases with four deaths. Whilst this represented a great reduction in the operative mortality he states that "the chief cause of death is toxæmia, and that death after operation occurs in spite of removal of the appendix and not because of it, on account of this same toxæmia."

In the same Journal on Feb.24, 1912, he published a list of 500 operations in cases of acute appendicitis. In 144 cases the operation was performed within 48 hours, and in five cases a fatal result ensued. He attributes three of these to the effects

of the chloroform used. In the remaining 356 cases, 35 deaths took place, and he explains the causes of these fatal results as follows:—Shock, collapse and toxæmias, 26; sudden cardiac failure, 1; acute nephritis and uræmia, 1.

The first group consists almost entirely of toxæmias, for severe shock is very rare in these cases and collapse is largely the result of the toxæmias, and the other two cases were probably toxæmic in origin. The chief cause of death in these cases is a natural toxæmia greatly intensified and probably rendered fatal by the administration of chloroform. The exclusion of this anæsthetic in these cases has been followed by a great reduction in the post-operative mortality.

If, however, we are to obtain a clear basis for the future investigation and proper appreciation of the post-anæsthetic toxæmias we must resort to pathological evidence. In 1850, Caspar was struck by certain post-operative deaths, inexplicable on surgical grounds, and which, he suggested, were due to the delayed action of chloroform. In 1884, Ferrier pointed out that albuminuria frequently occurs after chloroform administrations, and this has been confirmed by numerous other observers whose collective figures estimate the frequency at about 50 per cent. This is a point of great importance as indicating impaired function of the kidneys and subsequent intensification of any existing toxæmia as in the case of eclampsia and uræmia, which are really hepatic toxæmias precipitated and intensified by damage to the kidneys, which, within limits, protect the body by free excretion of the toxins. Pathologists are generally agreed that chloroform has a definite action on the heart muscle, liver and kidneys, producing granular swelling and fatty degeneration. Nothnagel has demonstrated fatty changes in the heart muscle of animals five hours after the administration of chloroform. Whilst we cannot by any means claim to a thorough understanding of the subject, these pathological facts afford a valuable basis for clinical classification. In cases of post-anæsthetic toxæmias these three organs—heart muscle, kidneys and liver—are affected in varying degrees, and three clinical types of toxæmia are recognisable, in accordance with which of the three organs is mainly affected. One can therefore distinguish: 1, a cardiac type; 2, a renal type; 3, a hepatic type.

1. *The Cardiac Type.*

This variety occurs chiefly in adults especially in cases of septic peritonitis and long-standing urinary infections. It is also not uncommon in very old patients whose hearts are in a state of brown atrophy. Such people usually take chloroform perfectly well, but are apt to exhibit mysterious heart failure a few days after operation. The chief features of the cardiac form are marked acceleration of the pulse; more or less normal respirations; vomiting, which varies according to the extent of associated hepatic involvement; physical signs of cardiac dilatation; sudden or gradual heart failure. Thrombosis and embolism may occur, the phenomena having their origin in the enfeebled heart.

2. *The Renal Type.*

The frequency of albuminuria after chloroform administrations has already been referred to, and careful examinations reveal the presence of casts in many instances. Fortunately the condition is usually transient, but in rare cases the condition may pass into urinary suppression and uræmia. In the ten fatal cases dealt with in this article distinct albuminuria occurred in three instances, and in one of these urinary suppression occurred. One case of this type also is mentioned in Mr. Burgess's list. The chief importance of this damage to the kidneys lies in its influence on any existing toxæmia. As long as the kidneys are healthy no serious result may occur as the toxins are removed as rapidly as they are formed, but interference with the renal function rapidly intensifies the toxæmia.

3. *The Hepatic Form.*

This is the commonly recognised variety and its features are so well described in the text-books that it is redundant to reproduce them here. The special features in the enclosed list of ten fatal cases have already been tabulated, the chief features of note being the absence of the " coffee-ground " vomit, and the terminal hyperpyrexia, convulsions and coma.

Indications for Prevention and Treatment.

There is a tendency among certain medical men to look

upon post-anæsthetic toxæmias as exquisitely rare, and when they do definitely occur and lead to a fatal issue as an unfortunate yet unavoidable occurrence. The frequency of post-anæsthetic toxæmias after all general anæsthetics has been established by modern physiological methods on the reaction of the blood. Almost all patients exhibit a mild but detectable degree of acidosis after a general anæsthetic. Acidosis is of two types, the first, " true acidosis," which involves a disturbance of the acid-base equilibrium or pH of the blood, and diminution of the alkali reserve. This effect is immediate. The second is " ketosis," and is characterised by the accumulation of ketone bodies in the blood, probably the result of subnormal oxidation of carbohydrates. This form develops several hours after the withdrawal of the anæsthetic. The influence of the various factors on these post-anæsthetic toxæmias is now better, though by no means completely, understood.

1. *The Influence of the Anæsthetic.*

All the general anæsthetics produce the two types of acidosis mentioned above (Leake). The changes are more severe after chloroform than ether. Chloroform causes a greater diminution of the alkali reserve (Morris) and is more toxic to the kidneys (McNider), an action which increases the toxæmia by retention of the toxic agents. Further, after chloroform, diuretics will not re-establish the urinary flow, whereas after ether they are effective. My own clinical experience (15 years at a Children's Hospital), together with detailed investigation of 700 cases, leads me to the conclusion that whilst slight ketosis is common with open ether it very rarely causes any anxiety even when an acute toxæmia pre-exists.

Nitrous oxide and oxygen are usually looked upon as non-toxic but such is not the case. The presence of slight impurities in nitrous oxide may have a detrimental effect in long-continued administrations. A special committee is at present investigating this question under the Medical Research Council. Even if the gas is pure it is impossible to maintain a satisfactory anæsthesia without a certain degree of anoxæmia, and the oxygen shortage causes a similar but less intense acidosis than chloroform and ether. In the case of ethylene

15 per cent. of oxygen may be used without impairing its anæsthetic properties, and thus anoxæmia can be avoided. Its effect on the blood reaction after 40 minutes anæsthesia is practically negligible (Leake). As far as the selection of anæsthetics goes chloroform alone or in mixtures should be avoided in children, and in any case where there is any evidence of a pre-existing toxæmia. Ether by open methods or gas any oxygen with the occasional addition of ether is to be preferred. Unfortunately, an adequate supply of ethylene is not available in this country.

2. *The Oxygen Factor.*

Oxygen limitation is in itself a cause of acidosis as pointed out in discussing nitrous oxide and oxygen. On this account alone chloroform is to be strongly condemned, for Gardner and Buckmaster have shown that this agent reduces the oxygen content of blood from 13.6 to 8.1 per cent. This also probably explains the readiness with which chloroform produces fatty degeneration. Whatever anæsthetic is preferred it is wise to administer oxygen with it. For similar reasons closed methods are best avoided as there is a tendency to develop a certain amount of anoxæmia, and to use too strong a vapour.

3. *The Condition of the Patient.*

The existence of toxæmias prior to operation should always be carefully tested for. The presence of sugar and albumin at once reveals conditions in which post-anæsthetic toxæmias may become excessively dangerous. Tests for pre-existing acidosis should also be performed, particularly in children. The ferric chloride test for di-acetic acid in the urine is still the most convenient clinically, but other physiological tests for acidosis are now available for special cases though scarcely simplified enough for routine application. The functional efficiency of the chief organs concerned, viz., the heart muscle, kidneys and liver, should be determined where definite toxæmias exist. These have been described by the writer in a former paper in the *British Journal of Anæsthesia* (Vol. I, No. 4, 1924).

4. *The Dietetic Factor.*

The second, or "ketosis, type" of acidosis is probably due to subnormal oxidation of carbohydrate. This may be due to a deficient supply of carbohydrate or to impairment of the mechanism of oxidation. As regards defective supply of carbohydrate, both Frew and Ashby have shown that sudden alteration in diet or starvation produce ketosis and that this readily clears up on the administration of glucose. As regards the fatal cases recorded in the earlier part of this paper I am of the opinion that rationing of food and the sugar shortage existent at that time (1917) played an important part in their occurrence. In any case, two of the chief recommendations which I made to the Medical Board of the Hospital were that they should make application for a special supply of sugar and that the children should be kept in hospital four or five days prior to operation and appropriately dieted, and the epidemic of unfavourable symptoms promptly cleared up.

Glucose should be given for two or three days before operation in the form of barley sugar, raisin tea, or sweetened liquids. A final dose may be given by mouth or rectum two to three hours before operation. More recently orange juice has been utilised with very satisfactory results, but its precise mode of action is not fully understood.

5. *The Question of Preliminary Drugs.*

The addition of morphine to the preliminary atropine is to be strongly recommended partly because it enables one to reduce the amount of anæsthetic used, and partly because it provides a more satisfactory degree of anæsthesia whenever nitrous oxide and oxygen are selected for use. The administration of alkalies is, at the present time, a debatable problem. Observations on blood reaction with these drugs are against their use. Until further information is available they are best avoided.

6. *The Nature of the Anæsthesia.*

The influence of the personal factor in these cases is difficult to estimate. The Surgical Staff were of the opinion that

serious toxæmias were less common with experienced anæsthetists than with the hospital residents. Special attention to certain points in the administration will certainly lessen the toxic risks. The reduction of the anæsthetic to a minimum, the free use of oxygen, the avoidance of closed methods, and, finally, de-narcotisation are all of the utmost importance. I attach great value to de-narcotisation for which purpose I use oxygen containing 5 per cent. of carbon dioxide (cylinders containing this mixture are provided by the British Oxygen Co.). The process is commenced about ten minutes before the end of the operation, and the patient is practically round just after the operation is complete. The excretion of the anæsthetic is greatly accelerated and after-sickness practically non-existent.

7. The Influence of Insulin.

It has already been pointed out that post-anæsthetic ketosis may be due to an inadequate carbohydrate supply or to a defective carbohydrate oxidation. The former is correctable by the dietetic measures already mentioned. The latter condition can be dealt with by the use of insulin. Thalhimer and Perry have found that this post-anæsthetic acidosis readily clears up when insulin and glucose are administered. Their essential routine is to administer 1000 cc. of 10 per cent. glucose intravenously. This injection is spread over five hours. One hour after the injection is begun 20 units of insulin are given, and one hour later another 10 units. This usually clears up the acidosis; if it does not, repeat the treatment next day. I have personal knowledge of a recent case of delayed chloroform poisoning in a child which one would have expected to terminate fatally but which cleared up under this treatment. In this case the glucose was given per rectum and the dose of insulin was 5 units. Insulin appears to be an invaluable addition to the treatment of these cases of post-anæsthetic toxæmia.

NITROUS-OXIDE = ACETYLENE = OXYGEN ANÆSTHESIA FOR EXTRACTION AND ORAL SURGERY.

By

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New York City.

(Presented before the Fourth Annual Congress of Anæsthetists, at Atlantic City, May 25—28, 1925.)

Continued from page 88.

Preparation of the Patient.

No food for four hours or more before administration. The toilet necessities are attended to. Clothing so arranged as not to interfere with the breathing. Appliances, such as hernia belts, should not be removed.

Posture.

Back-rest—30 to 40 degrees to the horizontal. The position of the head should be such as not to produce undue strain of the muscles. The head should be *parallel* to but *not* in line with the back. We all stoop; the older the patient the greater the stoop and the more will the head be forward of the shoulders.

Physical Examination.

Questions as to health, references to heart disease, stethoscopic examination, generally speaking, produce more harm than good. If the patient can walk into your office, nitrous-oxide-acetylene-oxygen, properly administered, will not be contra-indicated.

Confidence—Good Cheer.

Our usual routine is to have the patient's friend, if the patient is not alone, in the operating room with him. It reassures him as does your good cheer, your smile, your confidence, and as does the smile of the patient who has just come out of the operating room.

We are believers in stage-play or suggestion—whatever you may call it. The sterile instruments, in a sterile towel,

have been laid out, if possible before the patient enters the room. You speak your few lines, the nurse speaks her few lines—words that you have probably repeated ten times already that day—words to calm, to comfort, to reassure—words giving ease, good cheer, and confidence to the patient. After a few inhalations, by a sign of your hand and eyes, you ask the patient's friend to return to the waiting room. At the beginning of the inhalation, words of commendation and reassurance are in place. The tone is more important than the comment. It should be soothing. Your voice and words can be made reassuring, hypnotic. A proper choice of words suiting the occasion can surely be made of value. "Breathe easily, normally." "Think of something happy." "You are a very good patient." "You're the best patient."

Foresee the Effects.

The anæsthetist must remember that the control of the gas-taps does not at once control the gas supply in the blood. What you feed through the cylinders at one moment is not what the patient's tissues are receiving at that moment. It is not what the patient's lungs are receiving at that moment. Nor does it even determine at once the combination of gases in the breathing bag. The anæsthetist judges what the effect of the concentration he is giving at one moment will be in a little while. He knows that the effect upon the patient at the moment he is turning the taps is a result of what the patient received some time back.

End of Anæsthesia.

At the completion of the operation—whether it be merely a single extraction or an extensive operation—the gases are cut down. By the attached string you remove the gauze packing in back of the mouth. You replace it with a similar packing, probably not so far back. You swab out the mouth with sterile gauze and place a gauze pack over the area operated. The oxygen is being continued for a while, with carbon dioxide. You have given an anæsthesia simulating natural sleep. From natural sleep one awakens quietly, slowly, serenely, peacefully, calmly. Let the patient return to full consciousness as serenely, as calmly. (As you note that he has come to sufficiently to understand you, you may

say in a cheerful, soothing manner, "That's fine . . . You're a splendid patient . . . . very pleasant . . . . very pleasant.") The patient is regaining full consciousness. You ask him not to soil his clothing—to spit into the basin which is held at his chin. You ask him to push out the mouth prop with his tongue. If he is attempting to remove the prop but appears to have difficulty you say, "Shall I help you?" and gently disengage the prop.

Rinsing.

We have before emphasised our opinion that rinsing is not indicated. It is merely a tradition the patient has inherited. Generally he should be told not to rinse for about two hours after the operation.

Hæmorrhage.

We believe more cases of hæmorrhage after extraction are caused by the following two factors than by all the other factors combined.

(1) Disturbance immediately after extraction by superfluous rinsing while the patient is still at your office and for the day following.

(2) Disturbance of the wound one or two days later in removing the graying film over the wound, or in probing the area of extraction.

A Typical Experiment.

The subject will probably be made more lucid if we report a meeting of the New York Society of Anæsthetists (March 26th, 1925). Part of the evening was devoted to experiments upon animals with acetylene-oxygen. At 5.30 p.m. an albino rat was put into a glass container with an inlet and an outlet for the gases. A concentration of 30 per cent. oxygen and 70 per cent. acetylene was passed through the container for three minutes and the albino then inserted and the stop watch started. The animal was on his back in two minutes. We went out for dinner and returned in 40 minutes to find that the animal was deeply anæsthetized, breathing regular, machine-like; colour good. The concentration of the gases had changed slightly to acetylene 70 minus and oxygen 30 plus. At 7.49 p.m.—the animal under anæsthesia over 2¼ hours—the acetylene tank was becoming empty. The con-

centration had changed to acetylene 72 per cent., oxygen 28 per cent. No valves had been touched since they were set at 5.30 p.m. We attached a fresh acetylene cylinder and reset the concentration at—acetylene 70 per cent. and oxygen 30 per cent. At 8.25 p.m., while a group of us were comparing various anæsthetics we noticed that the animal, oblivious to all that was going on about him was in good colour, respiration regular, while we, the anæsthetists, were almost equally oblivious to him. At 8.30 we retired to another room. The meeting was called to order. No one was left in the room with the animal. The concentration had changed slightly—acetyline 68 per cent., oxygen 32 per cent. At 9.45 p.m. Dr. Erdmann and one of us stepped in to look at the animal and found that his respirations were regular, and his colour good. The concentration had remained almost unchanged. At 10.15 the meeting was adjourned and we all went in to look at the animal. The concentration was acetylene 72 per cent., oxygen 28 per cent. The respirations were regular, the colour good. We discussed the apparatus. The only new feature is two flow-meters to indicate the rise or fall of the pressure of the two gases by the rise or fall of two columns of coloured water in two ordinary glass "U" tubes. The gases are tapped before they enter the sight-feed and are led to the flow-meters by rubber tubing. Here is the percentage chart:—

Oxygen Pencentages.

Oxygen Readings.	Acetylene Readings.							
	4.5	5.0	5.5	6.0	6.5	7.0	7.5	8.0
4.5	28	20	15	12	10	8	7	6
5.0	40	30	24	20	16	14	12	10
5.5	50	39	32	27	23	20	17	15
6.0	61	50	42	37	31	28	24	22
6.5	70	61	53	47	41	37	33	30
7.0	76	67	60	55	48	44	40	36
7.5	79	71	65	59	53	49	45	41
8.0	82	75	69	64	58	53	49	45

We determine the volume rate of flow for every rise of ½ cm. from 4½ cm. to 8 cm. for each gas. This is checked by collecting many samples and analyzing them chemically, separately for oxygen and acetylene.

Precautions.

Dr. . . . . asked about the explosion hazard. We answered that in this type machine we see little danger if the thermo-cautery is not used. In Germany acetylene-oxygen has been administered over 25,000 times. Professor Gauss alone has had it administered in his clinic for over 5,000 operations lasting from a few minutes to over four hours. Thus far only one explosion, that reported by Professor Hurler in the *Münchner med. Wochenschrift*, October 1924. The patient suffered some burns of the skin. No one else was hurt although much excitement was created in the clinic by the noise of the explosion. The blame rests directly upon the operator who took lightly the warning that a thermo-cautery should not come in the vicinity of the anæsthetic. This operator had disregarded the warning frequently. This time as he was removing the cautery from the abdomen the explosion took place. A few weeks later, following a paper by Professor Gauss, Geheimrat Doederlein, the director of the Münchner Frauenklinik, stated that the advantages of the new anæsthetic had no relationship to its one disadvantage—thermal cautery not to be used. The new anæsthetic is again being given extensively at the clinic. This is the only explosion that has been reported with acetylene-oxygen. The sad experience at Johns Hopkins of a year ago was mentioned. Drs. Gwathmey and Buchanan and a number of others are convinced that that was an oxygen explosion. A number of explosions with ethylene due to static sparks in cold dry weather were mentioned. Fortunately little harm was done in any of these accidents.

Humidification.

In a letter to us Professor C. M. L. . . . . writes: "The danger of explosibility is present simply from static which may be generated by the flow of the gas past a metal opening." Our answer in part is: "If the gas is humidified by passing through water before it reaches the metal opening, can a static spark be created?" In a letter to Dr. Herb and to Dr. McMechan we stated that, "Dried rubber will encourage the creation of a static spark. However, if the

rubber is kept moist a static spark will not be caused." We would rather turn this into a question at present.

A spark may be created, say by the operator's gown touching the metal nose-piece. This, however, can be made of a material contact with which will not create a spark.

In a report on explosibility of ether led through pipes, the A. I. du Pont de Nemours Company (1919) mention the use of small metal arrestors in the piping. May not one be placed between the breathing bag and nose-piece?

" In the early history of Zeppelins, the static spark danger, we understand, was met by coating the Zeppelins. In flour mills, we are told, much damage used to be caused by sparks from belting touching off the very combustible particles in the air, and that danger has been overcome."

The incidence of ether explosions it would be well at this time to clear up. That they occur in this country a number of times a year is certain.

Five Hours' Anæsthesia—Awake in One Minute.

In the discussion, the albino rat, deeply asleep, breathing regularly, in good colour, has been forgotten entirely. At 10.30 p.m., five hours since the commencement of the anæsthesia, the stop watch is set—we remove the animal into the open air. In less than one minute he is on his fours walking about the table. In no way that we can recognize does he show any signs of having been under an anæsthetic.

" Would it be a brilliant thing to put a flame to an ether soaked towel?" Such and similar not very brilliant statements we have been guilty of—statements showing an ignorance of the danger from static and pyraforic sparks. As a matter of fact we used ethylene-oxygen for many months totally ignorant of any danger from sparks.

We have also stated that "Acetylene is no more dangerous than ethylene, and that ether is more explosive than both." Here again the wish may have been father to the thought.

What is the truth? We do not know, though we have been seeking it from hazard experts, fire underwriters, engineers, chemists, etc.

A static spark can be produced by rubbing the feet along a carpet and touching a bit of metal. Enough of a spark may

thus be created to light ordinary illuminating gas. If, however, you wear rubber gloves no spark can be carried from any part of the glove. In cold, dry weather static is more readily created than when the humidity is high. Means can be furnished to sufficiently humidify an operating room to either produce or to entirely eliminate the possibility of creating a static spark—conducted either from a person to a piece of metal or from one piece of metal to another.

As to sparks caused by two metals striking each other:—

(1) Sufficient force is necessary.
(2) Metals vary. Two steel instruments striking each other with great force will produce a spark. We doubt whether two pieces of aluminium can be made to strike with sufficient violence to raise sparks.

If a spark could be caused by a forceps striking a tooth filling or striking a crown, the use of ethylene or acetylene should be stopped at once. But sparks cannot be produced in that way.

"*What is your technique?*" Our work is extraction and oral surgery. We apply the nose-piece with the usual care. A mouth prop is inserted. We commence by administering nitrous oxide and oxygen about 95 per cent. and 5 per cent. After 10 to 15 inhalations we substitute acetylene for nitrous-oxide—20 per cent. oxygen. In about one minute we remove the covering over the mouth and insert a pharyngeal pack. We examine carefully the area of operation. Every two or three minutes we increase the oxygen until 50 per cent. acetylene is being given. We have seldom gone lower than 50 per cent. acetylene.

"*Why do you commence with nitrous-oxide and oxygen?*" Because of the unpleasant, garlicky odour of the acetylene. In some of the German clinics the gas is passed over pine flavour.

"*Is acetylene compressed into tanks like nitrous-oxide or ethylene?*" No. If it were the chemistry text-book list of dangers would be correct. But since 1897 it is not put up that way. The tanks are filled with cement-asbestos fibre

which divides the space into infinitely small spaces. The gas is dissolved in acetone. A bullet may be fired through the tank without danger. These tanks are daily bumped over bad roads in thousands of automobiles without danger.

Someone noticed a tank of carbon dioxide attached to the apparatus. *"Have you used carbon dioxide?"* In some cases after the induction we add carbon dioxide to the other gases and maintain it at 5 to 10 per cent. until the operation is over, when we discontinue the acetylene and nitrous-oxide, and increase both the oxygen and the carbon dioxide. At other times we add carbon dioxide only at the end of the operation.

"What advantages has acetylene plus nitrous-oxide plus ethylene with oxygen over acetylene alone with oxygen?" We believe that the principles of synergism apply. Were we to return to nitrous-oxide and oxygen we would as formerly add small amounts of a vapour synergist. The principle of synergism is seen clinically to apply. James T. Gwathmey five years ago before the American Association of Anæsthetists: "The theory upon which this special form of anæsthesia depends is based upon the fact that each of the agents used affects the nervous mechanism in a different place and in a different way, with a resultant anæsthesia that is more nearly perfect than if any one agent is used . . . ."

What Theory is Acceptable?

There are a dozen or more theories to explain the loss of consciousness with ether, chloroform, nitrous-oxide, etc. One of these theories is that recalled by Dr. Jones, in his article on "General Anæsthesia" in the March issue of the *Dental Items of Interest*. He says that: "It is his belief that lowered oxidation is not only an accompaniment of anæsthesia but that it is the essential feature of anæsthesia."

Acetylene-oxygen anæsthesia as presented by Wieland and Gauss in Germany and by ourselves in the United States raises many questions touching upon the "Reduced oxidation theory."

Facts or Fancies.

1. The air is a physical mixture of nitrogen 79 per cent. and oxygen 20 per cent. The blood takes up this mixture.

The nitrogen as it passes through the body undergoes no chemical change.

2. Nitrous-oxide and oxygen are coursed through the body by the blood. The nitrous-oxide undergoes no chemical change in the blood or in the tissues. With ethylene the blotches of extreme pinkness that are noticed frequently, although the oxygen content is far below normal, has led Luckhardt to believe that there is some loose combination of ethylene with hæmoglobin. With acetylene we have noticed nothing similar. German laboratory workers have told us that acetylene is as indifferent as nitrous-oxide.*

3. Nitrogen has a low power of saturation with water or blood—4 volumes per cent.

4. The saturability of nitrous-oxide in water or blood is much higher than that of nitrogen. Nitrous-oxide about 50 volumes per cent. Ethylene and acetylene have a still higher saturability. Acetylene saturability at body temperature in blood is 74 volumes of acetylene for 100 volumes of blood.

5. In the stages of development nerve tissue is the last tissue developed. To function in the animal or human body that tissue requires much more oxygen than the other tissues —twice as much. When the oxygen supply is below normal the higher mental centres are the first to be affected and the vital tissues the last.

5a. In the average nitrous-oxide and oxygen anæsthesia the oxygen supply is reduced to 6 to 8 per cent.; less than half the normal. The margin of safety is about 2 per cent.; the vital processes cannot continue in the average human on less than 6 per cent. oxygen.

* (*Zeitschrift f. Physiol Chemie*, 127, 243—1923, page 254.) "The assumption made by several investigators that acetylene enters into chemical combination with the blood is now definitely refuted.

"Also Manchot's theory of a loose combination (chemical) with blood under certain temperatures is shown to be false. Herman, as early as 1874, stated that blood and acetylene enter only into physical combination. We find that correct.

"The oxygen absorption is in no way hindered by the presence of acetylene.

"*Resumee*: The absorption of oxygen by the blood is no differently affected by the presence of acetylene than by the presence of nitrogen."

(*Zeitschrift f. Physiol. Chemie.* Vol. 131, page 131.) "The capacity of the blood to take up oxygen is in no way changed by the presence of acetylene.

"*Resumee*: The presence of acetylene affects in no way the oxygen content of the blood."

5b. With ethylene the oxygen supply varies from 7 to 12 per cent.

6. Limiting ourselves to nitrous-oxide and oxygen, and to ethylene and oxygen anæsthesia, we have an apparently workable theory. Anæsthesia is produced through the reduction of the oxygen supply sufficiently to affect consciousness, pain apperception, and pain perception. The oxygen must be in sufficient quantity for the respiratory and cardiac functions to continue.

7. With acetylene instead of nitrous-oxide what happens to our above theory?—a theory we might extend to explain local anæsthesia as the reduction of oxygen supply to the nerve endings. With acetylene the oxygen supply of the inspired gases is never less than 30 per cent. and usually above 40 per cent.

8. When we spoke of 7 per cent. oxygen with 93 per cent. nitrous-oxide the reader had probably taken it for granted that this oxygen content in the inspired gases meant the same to the blood and to the other tissues as 7 per cent. oxygen with 93 per cent. nitrogen. But must not the saturability be considered? The fact is that nitrous-oxide is about ten times as soluble in the blood as is nitrogen. We may expect less reduction of the oxidative processes when 7 per cent. oxygen—93 per cent. nitrogen is inspired than when 7 per cent. oxygen and 93 per cent. nitrous-oxide are respired. And so the more soluble a gas the more reduction of the oxidative processes with an equal percentage of oxygen. Ethylene is more soluble in blood than is nitrous-oxide. We may therefore expect less reduction of the oxidative processes when 7 per cent. oxygen is inspired with 93 per cent. nitrous-oxide than when 7 per cent. oxygen is inspired with 93 per cent. ethylene. Acetylene is still more soluble than is ethylene. In a former article we said that if acetylene, ethylene, and nitrous-oxide were equally indifferent, the organism would tolerate each with an equally low percentage of oxygen. What we have said above shows how incorrect we then were. Professor Hermann Wieland in a personal communication (March 1925) says: "The action of a gas is logically determined not by its inspired concentration but by its concentration in the blood, or rather in the tissues. As the solubility of acetylene is

greater than that of nitrous-oxide, an equal concentration in the blood is attained with a lesser concentration of acetylene in the inspired gases. According to my belief anæsthesia is secured when a certain, still unknown, concentration is secured in the nerve cell—which when expressed in volumes per cent.—is the same for all these gases. I have no figures at hand for the solubility of gases in blood at body temperatures. These figures would also not be decisive in such a calculation as the rate of diffusion of acetylene and nitrous-oxide in the tissues is not known. When one considers that the presence of a certain number of gas molecules in a cell will interfere with oxidation—even with a high percentage of oxygen—then one will understand the apparently more powerful action of the more soluble acetylene."

ALPHA-LOBELIN.

Henry Wieland, of the University of Freiburg, in 1915, isolated for the first time the pure alkaloid Alpha-Lobelin. His brother Herman, now Director of the Institute of Pharmacology, Heidelberg, studied the drug from the pharmacological standpoint, and announced a difference between it and the old Lobelin preparations. Further experiments demonstrated the new alkaloid to be a direct stimulant to the respiratory centre, Wieland securing an increase of respiratory volume in a rabbit of 4.59 per cent.

The drug was next studied in the Children's Clinic of Freiburg by Eckstein and Rominger, where extremely encouraging results were obtained in overcoming central respiratory depression due to chloral hydrate poisoning, respiratory collapse and asphyxias.

Since then a considerable literature has appeared, but the basic studies of the original workers have practically remained unchanged. Hallendall and Bonsmann demonstrated the drug to be a physiological antidote to morphine and scopolamine. Puppel and Hoechstenbach, taking up its effect upon the respiratory failures due to anæsthetics, found it succeeded where other methods failed. Cases of respiratory collapse in carbon monoxide poisonings, asphyxia neonatorum, severe hæmorrhages, traumas, and in various other allied conditions, have all been demonstrated to have been overcome or helped by Alpha-lobelin. Recently, Hofmeister and Reichle have (*Med. Jl. and Rec.*, Oct. 21, 1925) published a list of seven cases where the drug was used by them, and they draw the conclusion that the preparation is a powerful respiratory stimulant. They suggest that with carbon dioxide this drug may prove a worthy synergist.

Correspondence.

GAS AND SUDDEN COLLAPSE.

To the Editor of "British Journal of Anæsthesia."

SIR,

Mr. Boyle's narrative of two cases of collapse is of great interest and importance. I have little doubt that the collapse was due to acute dilatation of the heart. Such a condition is liable to occur both with nitrous oxide and air inhalation and in the case of nitrous oxide and oxygen. In my book (6th edition, p. 126) I quote cases which are germane. In the *Transactions of the Society of Anæsthetists*, Vol. ii, 1899, p. 185, Mr. Crouch details two instances in which he actually observed this dilatation of the heart. There was no cyanosis, a point of physiological importance. Further, it should be noted that both of Crouch's cases were septic, and Boyle's first patient was also septicæmic. Indeed, it is worthy of remark that in the cases of faintness, and they are not rare, with which one meets after inhalation of nitrous oxide and oxygen usually occur in dental practice when several teeth have to be removed for pyorrhœa alveolaris—a septic condition. These cases, I have little doubt, are potential instances of collapse. My notes show that nausea and vomiting are more frequent after nitrous oxide and oxygen than after nitrous oxide given by itself, and I submit these symptoms are cardiac rather than gastric in origin. One is able to "charge up" the patient with a larger amount of nitrous oxide when using it in the mixture. The recovery is slower, the patient is more obfuscated, and often complains of feeling "strange," showing, I think, that the cerebral circulation is interfered with, as it certainly was—retinal anæmia—in Boyle's second case. Further, Dr. Baldwin (*Med. Record of New York*, July 29, 1916) strongly insists upon the possible dangers of nitrous oxide and oxygen in major surgery, giving 1 per cent. as the mortality during its employment. The deaths which he records are, so far as my memory serves me, in many cases circulatory, and, I should judge, due to acute cardiac dilatation.

Of course, one must bear in mind that some patients *swallow* the gas, over-distend the stomach, and so produce syncope by mechanical interference with the heart's action. Some years ago I demonstrated that nitrous oxide, when inhaled, became associated with the erythrocytes, and was in part dissolved in the serum. Now it is, I submit, fairly certain that such an indifferent gas as nitrous oxide must cause friction as it is carried along the circulatory passages. This, we know, eventually leads to dilatation, and, given a weakened state of the myocardium, it is not unthinkable that even a brief inhalation may interfere with the cardiac circulation and cause dilatation, probably through peripheral blocking. Further, we know that in anæmic states and in septic conditions the myocardium undergoes pathological changes, while in the neurasthenic the nerve controls, as well as the myocardium itself, are peculiarly liable to fail the patient when a crisis occurs. Instance the syncope so common in patients who suffer from exophthalmic goitre.

If these facts are admitted and my reasoning is correct, there appears to be some evidence in favour of the view that sudden collapse occurring after inhalation of nitrous oxide diluted by oxygen or air is due to an acute dilatation of the heart, and this is especially liable to occur when sepsis is a feature of the case. There is in both Vol. ii and Vol. iii of the Transactions quoted much interesting reading which indirectly throws light on this and other sequelæ of nitrous oxide administration.

Your obedient servant,

DUDLEY WILMOT BUXTON.

GAS AND SUDDEN COLLAPSE.

To the Editor of the "British Journal of Anæsthesia."

Dear Sir,

I was very interested to read, in the October number of the Journal, Dr. Boyle's experiences of patients fainting after gas anæsthesia for extraction of teeth. I am afraid, however, that I cannot answer his question, "Why do these cases occur?" as the two experiences of

the same kind which I have had did not happen in patients whose appearance would have led one to expect syncope. The patients in whom one is well warned about some cardiac insufficiency are very often those with whom least difficulty is experienced.

My two cases both occurred some time ago. In both there were a considerable number of teeth to be extracted, and Loosely's continuous nasal apparatus was used throughout. The first patient was an apparently healthy woman of 30, very nervous. The anæsthesia was uneventful and unaccompanied by marked cyanosis. Recovery was rapid, and the patient was sitting forward washing out her mouth when the faint occurred. She had just time to put down the glass and sit back in the dental chair when she lost consciousness, with the usual symptoms of syncope. Her head was at once lowered, and inhalations of ammonia were given. Recovery was slow, the exact time I am unable to state. So far as I remember she had a little brandy, and, after half an hour, was able to walk, feeling all right. Unless in this case her extreme nervousness had predisposed her to an attack of this kind, I am unable to offer any explanation. The second patient was a woman about 45, spare and athletic, a keen tennis player. She had just recovered from an attack of influenza, had been examined by her family practitioner and passed as fit for a general anæsthetic. The anæsthesia was accompanied by rather more than usual cyanosis, but otherwise satisfactory. Recovery was delayed, and she was still in a somewhat dazed condition when the faint occurred. She had no recollection afterwards of any interval of consciousness between the anæsthesia and the faint. Again the recumbent position was immediately adopted, and ammonia inhalations given. As soon as she recovered sufficiently she was also given sips of brandy. Complete recovery took longer than in the other case, and nearly an hour had elapsed before she was able to walk. A possible explanation here for the syncope taking place was the overloading of her right heart, coupled with a slight post-influenzal myocarditis.

Attacks of this kind are sufficiently alarming when they occur, which fortunately is very rarely. I only recollect these two instances.

Yours faithfully,

H. P. Fairlie.

ABSTRACTS OF CURRENT ANÆSTHETIC LITERATURE.

Evaluation of cardiac efficiency by study of blood pressure. M. A. MORTENSEN. *Cur. Res. in Anæs. and Analgesia,* Dec. 1925.

Dr. Mortensen states that at the Battle Creek Sanitorium, Michigan, routine blood pressure readings at intervals of five or ten minutes during serious operations have proven of great value. A sudden drop in systolic pressure demands immediate consideration, a gradual decline may occur suggesting careful watching, and either condition may require the exhibition of adrenalin, or caffein hypodermically, or perhaps intravenous use of Ringer's solution, or possibly blood transfusion, to avoid serious complications.

Before operation and after operation, readings are regularly taken in most surgical cases.

Anæsthesia from the biophysical standpoint. DONALD C. A. BUTTS and E. A. TYLER. *Cur. Res. in Anæs. and Analgesia,* Dec. 1925.

The authors undertake to prove the theory that anæsthesia is a physical or atomic conception because such agents as ether, chloroform, nitrous oxide, ethylene are composed of nothing more or less than chemical molecules which are further sub-divided into atoms, and these into protons and electrons, which are definite electrical units or particles of electricity. Since, according to modern science, everything *in nature* is electrically constituted (except the *ether* of *space*) we may justly theorize that such influences as anæsthetic agents will interfere materially with the conductivity of electric currents along the elaborate wiring system of our bodies. When this interference is *temporary* anæsthesia or analgesia results.

Experiments with anæsthetic gases. W. EASSON BROWN and VELYIEN E. HENDERSON. *Cur. Res. in Anæs. and Analgesia,* Dec. 1925.

The authors report experiments with methane, propane, butylene and propylene.

They believe that methane is not a good anæsthetic, and the same may be said of propane and butylene. However, they think that propylene will prove satisfactory.

Observations on blood and tissue chemistry in relation to anæsthesia and safe operating. HENRY M. FEINBLATT. *Cur. Res. in Anæs. and Analgesia,* Dec. 1925.

Dr. Feinblatt, although speaking from the standpoint of the chemist only, believes that in the presence of inadequacy of the kidneys, the employment of general anæsthesia is extremely hazard-

ous. Any pronounced grade of urea or creatinin retention should contraindicate general anæsthesia. However, when the operation is designed to relieve the condition which causes the nitrogen retention this objection does not apply. For example, in uremia due to obstruction of both ureters, surgical measures are well advised. Local anæsthesia would be the first choice; certainly chloroform and ether are contraindicated.

Anæsthesia in the presence of medical disease complicating surgery. E. E. Allgeyer. *Cur. Res. in Anæs. and Analgesia,* Dec. 1925.

In studying the records of 130 anæsthesias under conditions in which medical disease complicated surgery the author comes to the following conclusions as to the type of anæsthetics suitable in each class:—The tuberculous patient offers much concern if the process is *active*. Any other but gas-oxygen (nitrous-oxide or ethylene) is absolutely contraindicated. In abscesses of lungs, thoracotomies, bronchial asthma, and acute bronchitis, ethylene-oxygen is preferable. In diabetics he advocates ethylene-oxygen or nitrous-oxide-oxygen, and ethylene is the choice in nephritics. Generally speaking, a gas anæsthesia is the one choice in the added complication of a medical disease; ethylene seemingly having the advantage over nitrous-oxide because of its somewhat greater depth of anæsthesia when mixed with nearly normal or normal amounts of oxygen.

Ethylene anæsthesia, with report of experiences in administrations. H. A. Thompson. *Cur. Res. in Anæs. and Analgesia,* Dec. 1925.

In most of this series the author started with nitrous oxide and after half a minute changed to ethylene. The odour of the former is much to be preferred. The ethylene alone has a very disagreeable odour, but when combined with a large percentage of oxygen it is usually not complained of by the patients. He keeps the patient under from five to ten minutes before the surgeon begins to operate, as this allows of time for better relaxation. For abdominal cases he uses a preliminary of morphine and atropine because owing to quick recovery from the ethylene any pain present is thus minimised. He finds that 10 to 20 per cent. of oxygen is a proper proportion with most patients.

One of the greatest advantages is the lack of depression and the ability of the extremely poor surgical risk to be carried through a trying operation under ethylene and be returned to bed with little or no evidence of shock.

There are two disadvantages:—First, its explosive power. In dilute mixtures with oxygen (about 4 per cent.) it is very explosive. In its purity, or with much higher concentrations, it is not explosive at all. Second, the relaxation is not always as complete as is desirable.

Somnifen in labour. SCHWARZ-KREBS. *Am. Jl. Surg.*, Oct. 1925.

In the recent French literature the use of somnifen, a derivative of the ureid group, which is a combination of diethylbarbiturate of diethylamin and the isopropylallyl-barbiturate of diethylamin, is described for semi-narcosis in labour. After the introductory work of Redonnet, Wiki and others, this preparation had its introduction to obstetrics by Cleisz and Perlis in France. The method is, briefly, an injection intravenously of 6 to 9 cc. of this substance, depending upon the weight of the patient, taking about three minutes for its injection. This procedure insures complete anæsthesia for from three to five hours. They state that sleep once obtained, there is no appresiable change in colour, respiration or pulse. Labour takes place normally but more rapidly than usual. Expulsion takes place spontaneously, the woman assisting excellently, although she is semi-conscious. If the patient should regain consciousness at the moment of expulsion a small inhalation of chloroform will restore anæsthesia. No effect has been noted on fœtal heart beat, the infants breathing normally and immediately. There are no signs of asphyxia or sleep in the new-born. The method is begun when there is dilatation in the primiparæ the size of a two-franc piece, but gives the best results if it can be delayed to the time there is dilatation the size of a five-franc piece. From their descriptions one would be led to believe that at last an ideal method has been found. At least their work warrants attention.

The cardiac reserve, and its relation to surgery. T. L. DEAVER. *Am. Jl. of Surgery*, Sept. 1925.

In this interesting paper Dr. Deaver arrives at the conclusion that the amount of cardiac reserve should be determined, as nearly as possible, in every patient who is to be subjected to major surgery. A complete physical examination, a well taken history, the usual analyses, the electrocardiograph, blood pressure, the metabolic rate and roentgenography, with special study of the pulse, both at rest and after exertion, are the more substantial means at our command. Great importance is attached to the correct interpretation of these findings. Even then, we cannot always estimate the strength of the heart muscle, and therefore of the cardiac reserve, since the limitations of physical life are more or less fixed by conditions over which we have no control.

Suspension of the cardiac reserve is not always fatal, for many persons have been restored to life by means of the pulmotor, massage of the heart and by injections of adrenalin chloride directly into the heart muscle, even when death seemed inevitable. When the cardiac reserve is exhausted, however, nothing known to science can again set in motion the machinery called life.

De-etherization with carbon dioxide. ETHEL RIGHETTI. *Am. Jl. of Surg.*, Sept. 1925.

Dr. Righetti speaks well of her experience with the use of carbon dioxide during ether anæsthesia. In 46 cases all proved satisfactory except in two small children who became livid, when, however, the Co_2 was immediately stopped. She found that its administrattion caused rapid de-etherization, and where a depression of respiration was met with its use caused deep breathing by producing the rapid ventilation of ether. Consciousness was hastened by it after the cessation of the anæsthetic. She thinks that post-operative pneumonia is likely to be prevented in cases where the full deep respirations induced by the Co_2 re-expand the collapsed areas in the lower lobes of the lungs following abdominal operations. She asserts that an emergency cylinder of Co_2 in an operating theatre is of more value than the usual oxygen cylinder.

Post-operative acetonuria. M. RABINOVITCH. *Russkaia klinika*, Moscow, March 1925.

Rabinovitch does not think that post-surgical acetonuria is due to excessive loss of blood during operation, to its duration, or to the anæsthetic. He attributes the acetonuria rather to restriction of diet previous to operation, and perhaps to emotional shock at this time. He found acetonuria more prevalent in women and young persons.

Acetylene anæsthesia. O. MALLEBREIN and J. H. MAIER. *Deutsche medizinische Wochenschrift*, Leipzig, Sept. 18, 1925.

At the Wurzburg Gynæcologic Clinic, in a series of 2,000 operations in which the anæsthetic was acetylene, these writers had only 0.3 per cent. of post-operative pneumonias and 0.3 per cent. bronchitis. There was no mortality. They found this type of anæsthesia especially useful in maternity work.

Local anæsthesia and blood pressure. L. A. ANDREJEW. *Deutsche Zeitschrift für Chirurgie*, Leipzig, Sept. 1925.

The author urges the supervision of the blood pressure during operation under local anæsthesia. In this way frequently the first signs of impending collapse may be observed, and by prompt treatment may be minimized. This observation was made as a result of a series of operations on fifty women and thirty-four men under local anæsthesia. He thinks that a few whiffs of ether at the time of greatest injury to the tissues are advisable if there is doubt as to complete nerve-block.

Respiratory paralysis following caudal anæsthesia. DAVID C. ELLIOTT. *Colorado Medicine*, Denver, Col., Oct. 1925.

In this paper a series of 600 cases of caudal anæsthesia is reported,

and the author concludes that toxic reactions may occasionally be met with. In this series there were two. To obviate this result he advises the addition of a prophylactic dose of caffeine sodium benzoate mixed with the solution injected.

Effect of insulin on patients after etherization and operation. LINCOLN F. SISE. *Am. Jl. Surgery*, Oct. 1925.

Following a report that an etherized dog's blood contained 0.29 units of insulin per 100 cc. of blood as compared with 2.93 units per 100 cc. in a normal dog's blood, and 1.66 units in a diabetic dog's blood, a series of 30 general operative cases were selected to observe the effect of insulin on patients after etherization and operation. No favourable effect on post-operative recovery as regards either vomiting or general discomfort resulted.

Narcosis by ethylene chloride, methylene chloride and their mixtures. D. M. ROSSIYSKY, Moscow, Russia. *Med. Jl. and Record*, N.Y., Nov. 4, 1925.

After experimental observations on narcosis of animals the author draws the conclusion that both of these haloid-producing methane, while not inferior in narcotic power to chloroform, exceed the latter in point of rapidity of the awakening. Also, while exercising a less paralyzing effect, as compared to chloroform, on the respiratory and vaso-motor centres and on the heart, they act less depressingly on blood circulation. Dr. Rossiysky states that narcosis administered to human beings by the mixtures have yielded most favourable results.

Respiration in anæsthesia control by carbon dioxide. YANDELL HENDERSON. *Brit. Med. Jl.*, Dec. 19, 1925.

Professor Henderson summarizes his conclusions as follows :—

The essentials of good anæsthesia are rapid induction, uniform concentration of vapour, and rapid termination. In the drop method of administration the vapourization of a liquid anæsthetic is often irregular. A more reliable and more uniform method of producing the vapour in proper concentration in air is desirable and is afforded by many of the forms of apparatus introduced recently.

The use of a controllable amount of re-breathing is also advantageous in the maintenance of a nearly uniform concentration of the anæsthetic vapour and of oxygen and carbon dioxide.

An almost complete control of respiration is afforded the anæsthetist by the use of carbon dioxide mixed with oxygen. By its use rapid induction and termination of anæsthesia and any desired volume of breathing and depth of anæsthesia are at his command.

The restoration of an approximately normal content of carbon dioxide in the lung air and in the blood and tissues of the body at

the termination of anæsthesia probably tends strongly to prevent the development of a post-anæsthetic pneumonia. It is also a means of restoring a nearly normal acid-base balance in the blood.

Resuscitation with alpha lobelin. O. HOFMEISTER and HERBERT S. REICHLE. *Med. Jl. and Rec.*, N.Y., Oct. 21, 1925.

The authors have used this drug in nine cases where rapid respiratory stimulation was urgently necessary, and regard their results as extremely satisfactory. They assert that it should be tried in respiratory collapse from hæmorrhage or anæsthesia subcutaneously in the dose of one-sixth grain for adults, to be repeated in twenty minutes, and for children one-twentieth grain; or intravenously one-twentieth grain and one-sixtieth grain respectively. The intravenous injections should be used only for cases where the circulation is obviously incapable of absorbing the drug and transporting it to the centre. They advise its employment in connection with Henderson's carbon dioxide-oxygen treatment.

Excision of perineal body of monkey under intra-arterial anæsthesia. J. P. ORLAND. *Indian Medical Gazette*, Calcutta, Aug. 1925.

In this operation the author reports that he obtained excellent and sufficient anæsthesia by slowly injecting into the lumen of the collapsed artery 20 cc. of a 2 per cent. solution of gum acacia containing one-quarter grain cocaine hydrochloride and five minims of epinephrin hydrochloride (1 : 1000). After a lapse of five minutes the head and neck were completely anæsthetized. There was no shock either during or after the injection.

Anæsthesia for thyroid surgery. LINCOLN F. SISE. *Cur. Res. in Anæs. and Analgesia*, Avon Lake, Ohio, Oct. 1925.

In this class of surgery the anæsthetic should be one which, beyond the production of anæsthesia, produces as little effect as possible on the patient's nervous equilibrium and on his bodily tissues and functions. The *thyro-cardiacs*, a name applied to patients with heart failure due to thyroid toxæmia, are among the worst risks.

Both nitrous-oxide-oxygen and ethylene-oxygen have several advantages which make them quite suitable for thyroid surgery. Ether may be used to deepen the anæsthesia, if necessary, and carbon dioxide accompanies the ethylene for a short or long period in accordance with the necessity of overcoming respiratory depression. In short, the routine adopted at the Lahey Clinic is nitrous oxide, ethylene, and oxygen, with carbon dioxide and sometimes ether, in whatever sequence or combination seems best fitted to meet the requirements of the case in hand.

Studies of the physiological action of propylene. LLOYD K. RIGGS and HAROLD D. GOULDEN. *Cur. Res. in Anæs. and Analgesia,* Oct. 1925.

In these studies the authors made 400 experiments on standard white rats from the Doursdoure Colony with a gas containing 99.6 per cent. of propylene. They also tried concentrations of up to 82 per cent. with about 25 per cent. of oxygen and some nitrogen on human beings. They found that the higher concentrations of propylene quickly produced unconsciousness with a degree of relaxation depending upon the concentration of propylene administered. Recovery was rapid, consciousness returning within one minute after its discontinuance. One of the authors took several of the concentrations and was anæsthetized to the point of unconsciousness thrice in one day without feeling any ill-effect except a slight inco-ordination which persisted for about fifteen minutes. Although 30 per cent. of propylene produced unconsciousness in the author, the rats required 40 per cent. to reach the same stage.

Pulmonary complications of surgery. NORMAN GWYNN. *Am. Jl. Surg.,* Oct. 1925.

The author takes up the cudgels of the anæsthetist who is charged with being responsible for post-operative pulmonary complications. He asserts that unless these began within 72 hours of operation he should insist on first having eliminated the possibility of embolism, infarct, fat embolism and collapse of the lung, for lung lesions beginning after 72 hours are rarely inflammatory and irritative or due to developing infection. Even in the earlier cases the anæsthetic has frequently nothing to do with the lesion; and the anæsthetist is then only an innocent bystander.

The action of propylene. BESSIE M. DAVIDSON. *The Journ. of Pharm. and Exper. Ther.,* Baltimore, Aug. 1925.

This paper is one of a series of " Studies of Intoxication " in which the effects of various low percentages of nitrous oxide, acetylene, ethylene, propylene ethyl chloride, methyl ether, caffeine and oxygen were noted. The effect on reaction times, memory, and ability to do simple arithmetical tests, were those particularly studied; but in comparing propylene with acetylene and ethylene the author notes that it is not only a more powerful anæsthetic, but can be used with a greater proportion of oxygen. 24 per cent. propylene in 33 per cent. oxygen produced unconsciousness in three minutes. It appears to be pleasanter to take, and has no bad after effects.

The papers on nitrous oxide and acetylene were printed in the April number, those on caffeine and oxygen in the September number of the Journal, and the others all in the August number.

The effect of ephedrine on experimental shock and hæmorrhage. K. K. Chen, Peking. *The Journ. of Pharm. and Exper. Ther.*, Baltimore, Md., Sept. 1925.

Ephedrine is stated to be an alkaloid isolated from a plant, the Chinese name of which is Ma Huang. Dr. Chen claims for this alkaloid that it stimulates the circulation by acting on the cardiac accelerator ganglia. He states that the rise in blood pressure produced by it lasts so long as to be of value in the treatment of such cases as Addison's disease, and suggests a trial for it in various low pressure conditions.

To test the effect of ephedrine, shock was experimentally produced in dogs, under luminal and ether anæsthesia, by histamine, peptone, anaphyllaxis (horse serum), trauma, hæmorrhage, and surgical manipulation. The fall in carotid blood pressure was used as the criterion of shock. Ephedrine sulphate was given in 1 per cent. solution, 1.5 to 3 m g. per kilo of body weight. In cases where the degree of shock, judged by the rapid fall of blood pressure, was very great, and respiration was shallow or had ceased, ephedrine had no effect unless artificial respiration were used as well. In all other cases, *i.e.*, where the respiration was still fairly good, the blood pressure rose almost to normal, in one case temporarily above normal, within two to three minutes after injection of ephedrine; and remained at a fairly high level for three hours or over. The effect was lost earlier in hæmorrhage, amounting to 25 per cent. or more of the total blood volume.

The author suggests that its chief value will probably be found in the rapidity of its action on the heart, which it stimulates almost immediately to more rapid and stronger action. The resultant rise of blood pressure is strikingly shown in a series of graphs of his various experiments. Dr. Chen suggests its use in emergencies, such as shock from hæmorrhage, while making preparation for transfusion. Its persistent action might have a prophylactic value against shock in long operations, or those in patients already suffering from shock. He stresses the fact that even repeated full doses seem to have no summation effect, and that no signs of toxic action have yet been noted.

JOHN JOHNSTON.

The physiological action of furane. ELIZABETH M. KOCH and MEYER H. CAHAN. *The Journ. of Pharm. and Exper. Ther.*, Baltimore, Md., Nov. 1925.

In the search for a local anæsthetic having the analgesic properties of cocaine without its disadvantages, various drugs have been tested. The authors of this paper have experimented with furane, a little-known liquid insoluble in water, with a boiling point of 32 C. The fact that it is volatile at and below body temperature suggested the possibility of its use as a general anæsthetic as well.

Inhalation experiments on animals (rat, rabbit, and dog) showed

that it did indeed produce complete analgesia and muscular relaxation lasting two to three minutes; but if the administration was continued after the period of induction, all the animals collapsed through respiratory failure. Further experiments, with and without the preliminary injection of atropine, proved that in the first place furane stimulated vagus action. Autopsy showed marked dilation of the heart and blood vessels, especially of the veins; great pulmonary hyperæmia, and a bright cherry-red colour of the blood.

By mouth, furane caused a copious flow of blood-stained saliva, and in one case hæmatemesis. The dogs used in this experiment survived from three to four days, and seemed to have progressively increasing insensibility to pain. On post mortem examination all organs and tissues were found to be hyperæmic and the blood more fluid than normal. The mucous membrane of throat and stomach were partly destroyed where the furane came in direct contact with it.

Intravenous injection of small doses was rapidly fatal, with the same post-mortem appearances as seen before. Respiration failed first, owing to paralysis of the medullary centres. Some rhythmic convulsive movements were noted, similar to those seen in prussic acid poisoning. Goldfish and yeast were rapidly killed by even very minute quantities of furane.

It is therefore concluded that furane, while possessing some anæsthetic and analgesic properties, is too toxic to be of any practical use in this direction. JOHN JOHNSTON.

Treatment of acute post-operative ileus by spinal anæsthesia. TASSO ASTERIADES. *La Presse Medicale*, 7th Nov., 1925.

My remarks concern only ileus following aseptic operations, and do not refer to cases of obstruction due to mechanical causes. The type of ileus with which I am dealing is spasmodic, and occurs within a few days of operation, and is immediately and effectively relieved by the administration of a spinal anæsthetic. Not having seen this form of treatment reported except by Mayer and Wagner in 1922 I am tempted to give an account of three cases in my experience in the French Hospital at Salonica.

Case 1. Appendicectomy for chronic appendicitis. From the day following operation the general condition began to change, vomiting and hiccough became incessant and the abdomen became enormously distended with visible peristalsis. A spinal anæsthetic was administered with novocaine, with the result that within a minute a copious action of the bowels occurred, accompanied by such volumes of flatus that the distended abdomen subsided and within a few moments became perfectly flaccid. No further distension took place and the patient was discharged cured on the twelfth day.

Case 2. Hysterectomy for double salpingitis. On the day after

operation the general condition of the patient altered and signs of intestinal obstruction set in with marked abdominal distension but with no signs of peritonitis; novocaine and caffeine were administered intrathecally with the result that within two minutes the whole picture was changed, an immediate evacuation of fæces and flatus reducing the abdomen to normal size. The patient left hospital on the fifteenth day completely cured.

Case 3. Nephrectomy for carcinoma. On the third day abdominal distension and signs of obstruction occurred and proved intractable to ordinary remedies, and spinal novocaine was resorted to with immediate and satisfactory results; there was no recurrence of obstruction but the patient succumbed, a month later, to renal insufficiency. A. L. FLEMMING.

The action of caffeine upon the meninges. E. CHAUVIN and L. JAUR. *Archives Franco-Belges*, 28th year, No. 2.

Hertz and Bloch have given us successive reports concerning caffeine as a remedy for syncope in spinal analgesia. If it can be shown that caffeine really has this effect when injected intra-thecally it would seem but logical that it should always be added to the solution of novocaine used for this purpose; and our clinical results with such a mixture were so satisfactory that we published them in the above *Archives* in 1921. We found that the addition of caffeine in no way diminished the potency or the absorbability of the anæsthetic drug, and that diffusion of the agent did not occur so that the level of anæsthesia was not interfered with.

We carried out investigations to test the action of caffeine upon the meninges. Clinically we observed no meningeal symptoms resembling the paraplegias and sphincter disorders reported by Guibal; there were headaches lasting for two or three days but these may occur with novocaine alone, and it was the laboratory which gave us definite information regarding the action of caffeine upon the meninges.

In eleven cases of spinal anæsthesia the cerebro-spinal fluid was examined before operation and upon the day following, and it was found that the number of leucocytes was always increased; the average increase in the eleven cases was in the proportion of 1 to 5; and the albumen was generally increased in the proportion of 1 to 2.

The conclusion we arrived at was that it was not permissible to add caffeine to novocaine for intra-thecal injection except, perhaps, in extreme cases of urgency. A. L. FLEMMING.

PROCEEDINGS OF SOCIETIES.

At a meeting of the Anæsthetics Section of the Royal Society of Medicine held on November 6th, with the President, Dr. F. E. SHIPWAY, in the chair, Dr. HAROLD SINGTON (London) read a paper on anæsthetics in children.

Dr. Singtou said that a child was not a diminutive adult. The central nervous system was much less stable than that of the adult. It was necessary to endeavour to gain the patient's confidence beforehand, and to take great pains during induction to avoid as far as possible unpleasant impressions and to shorten the period of induction to a minimum. Preparatory to operation, atropine sulphate should be given by the mouth, and not hypodermically. The dosage employed at the Great Ormond Street Hospital was: Up to 6 months, 1/300 grain, from 6 to 12 months 1/200 grain, from 1 to 2 years 1/150 grain, and from 3 to 6 years 1/75 grain, in solution in drachm doses, given one hour before operation. Over 6 years two doses of 1/100 grain were given two hours and one hour before operation respectively. Purging and enemata were dispensed with, starvation avoided, and glucose administered for several hours beforehand. Attempts should be made to explain things to the child, but once he had started to breathe the anæsthetic the induction period should be shortened as much as possible compatible with safety. Ethyl chloride and ether was the anæsthetic of choice in nearly every case, and was perfectly safe if there was a free airway. In dental cases ethyl chloride was the ideal anæsthetic for children. In 10,000 cases he had met with no fatalities, and only in two cases had there been cessation of breathing; both patients showed evidence of asphyxia, but recovered and were able to go home two hours later. When ether followed ethyl chloride his procedure was to give essence of orange in alcohol as a preliminary to spraying on the ethyl chloride, 3 to 5 ccm. In about three breaths the child was unconscious, and ether could be given in rapidly increasing doses. Ether was by far the best anæsthetic for children, and the only exceptions to this rule were when the actual cautery was to be used and in certain special cases mentioned later. Induction by chloroform and mixtures containing it was dangerous. Gas and oxygen with a minimum of ether vapour was the anæsthetic of choice for operations for congenital hypertrophic pyloric obstruction, acute intussusception, and in cases where there was prior starvation and much shock.

Dr. JOSEPH BIRT: He had given gas and oxygen in some 250 cases, including many of pyloric stenosis. There was little shock if cyanosis was avoided. Great viligance on the part of the anæsthetist was

necessary for the nice adjustment of the percentage of oxygen given. The ether vapour should be obtained by passing the gas over, and not through, the ether. The gas should be made to emerge close to the mouth, and not at the far end of the bag. The ether was necessary, especially at the initial incision, when closing the peritoneum, and at the final suturing of the skin. A narcotic should be given at the end of the operation.

The PRESIDENT agreed that the fright caused by a badly administered anæsthetic might easily lead to the development of night terrors. Ethyl chloride was the ideal anæsthetic, especially if given by the open or semi-open method, as these allowed of adequate supplies of air. He believed ethylene to be a better anæsthetic than gas and oxygen despite its inflammability and unpleasant smell, and it might turn out to be the ideal anæsthetic for children. Chloroform was certainly contraindicated, and he wished to draw the attention of the meeting to three specimens of fatty liver removed from patients who had died after the administration of this drug or a mixture containing it.

Dr. W. J. MCCARDIE considered chloroform still had a place in the anæsthetist's armoury for such cases as operations on the eye, brain, or mastoid. Ethyl chloride had its dangers, but was safe if given on an Armsby mask with equal quantities of ether. He was quite prepared to find that ethylene might be of use in children.

Dr. I. W. MAGILL had employed the intratracheal method in babies a few weeks old with satisfactory results, and thought it without danger. He used a No. 9 double French catheter in these cases.

Lady DICKINSON BERRY had administered many thousand anæsthetics for operations on the tonsils by the closed ether method with a Clover inhaler without ill effects, despite the fact that no atropine was given beforehand.

Dr. HUGH PHILLIPS questioned whether tact alone could deal with a refractory child; if so he would be pleased to hear the receipt. He preferred shock tactics in these cases—to knock out the patient as quickly as possible. He also thought that atropine did not act as well when given by the mouth as when given hypodermically. The danger of fright from the giving of a hypodermic injection reflected on the training of a nurse. He knew from personal experience that many nurses did not know how to give a hypodermic injection properly and painlessly. He thought the best method of anæsthetizing in special cases was to use gas and oxygen with local anæsthesia. In acetabular cases over three years of age he recommended that 1/10 grain morphine should be given with the atropine to prevent after-pain. He doubted whether chloroform could be placed entirely on the shelf; it was useful in cases of bronchoscopy and in operations for squint. He believed in inducing with ether and adding a little chloroform later; this was also useful in tonsillectomy cases. In his experience rectal

ether was a failure in children, as the oil-ether was not retained long enough to produce anæsthesia.

Dr. H. W. FEATHERSTONE said that even ethyl chloride was not always sufficient for a dental operation. He had recently reapplied the mask in such a case with the addition of 2 ccm. of ethyl chloride. The patient passed into a deep anæsthesia lasting five or six minutes. He wished to know why such a small addition of anæsthetic should have produced such a marked result. He had used rectal oil-ether with satisfactory results in a girl of 12 suffering from exophthalmic goitre.

Dr. Z. MENNELL said he intended to try the administration of atropine by the mouth. He asked what depth of anæsthesia and how much ethyl chloride should be given in any one case. He warned the advocates of chloroform of the danger of using this drug in decompression cases where there was much tension; a fatality was bound to occur. He believed that with skilled operators not necessarily surgeons, an anæsthetic was quite unnecessary for circumcising children under 14 days of age.

In reply, Dr. SINGTON said he had a horror of chloroform for children. He preferred closed to open ethyl chloride for dental extractions, as it gave a longer anæsthesia, but a free airway was essential. He believed that ether could be used satisfactorily for ophthalmic operations. He had no experience of endotracheal methods in children. Salivation at the beginning of an operation was due to the atropine not having been given sufficiently early; in such cases, if the mouth was well swabbed out, salivation did not recur.

At the December 4th meeting Prof. M. S. PERNBREY and Dr. F. E. SHIPWAY presented a paper on the subject of apnœa, dyspnœa, and cyanosis in relation to anæsthesia.

The President, Dr. SHIPWAY, said in part: The instruction, "Breathe deeply," might cause apnœa, as too much CO_2 was washed out. Respiration should be natural and easy. Rapid induction could not be obtained without a sense of discomfort, since the supply of oxygen must be cut down to get the necessary anæsthetic tension in the blood. Apnœa might occur during an anæsthetic. It was rare when chloroform was given through a tracheotomy tube, as the intake of air was unimpeded and the supply of oxygen was adequate in relation to the rise of CO_2. Apnœa as a complication was most likely to arise during intratracheal insufflation if the ventilation was excessive and the CO_2 washed out. Acapnia might occur during prolonged gas-oxygen anæsthesia, when expired air was allowed to escape through valves, and this could be abolished by instituting rebreathing. The presence of CO_2 in excess caused sweating, flushing, and rapid breathing, with a fall in pulse rate; but if there was a lack of

CO_2 the opposite phenomena were seen—pallor, cold clammy skin, shallow breathing, and a quickened pulse. This condition was now seen less frequently, as modern apparatus made provision for rebreathing. The acapnic phenomenon was often mistaken for shock, but acapnia leading to apnœa was seldom seen, as the lack of oxygen and formation of lactic acid in the tissues stimulated respiration. The danger of reduced partial pressure of CO_2 in the blood was increased during gas-oxygen anæsthesia if at the same time there was a deficiency of oxygen in the air inspired. Lactic acid formed during anoxæmia acted similarly to CO_2 on the respiratory centre and on the dissociation of oxyhæmoglobin. Apnœa seldom occurred during "open" ether, as the method was really a semi-open one. Analyses of air under such masks had shown that the percentage of CO_2 was adequate to stimulate breathing. The percentage ranged from 2 to 4. With chloroform anæsthesia, apnœa might lead to syncope, if followed by a resumption of breathing of a concentrated vapour. The action was direct on the heart. It might also occur during anæsthesia in old persons and those suffering from arterio-sclerosis. Cheyne-Stokes breathing could be abolished by oxygen or CO_2.

Excess of CO_2 produced hypernœa and dyspnœa, and was caused either by excessive rebreathing or by obstruction of the airway, in the latter case associated with lack of oxygen. If morphine or scopolamine were given (even with the addition of atropine) rebreathing should be instituted almost from the start and increased later to promote anæsthetic absorption.

Excitement and struggling during induction were largely asphyxial in origin, irregular strengths of vapour giving rise to reflex phenomena, such as swallowing, breath-holding, and feelings of suffocation when the concentration was high. Even the most difficult subject could be made to pass into anæsthesia, by ether given by the drop method, without a struggle if the strength of vapour were increased gradually. Again, the use of oxygen during induction, when cyanosis was present, eliminated or cut short the period of struggling. The most interesting of the signs of lack of oxygen—interesting because so often overlooked as to its significance—was the onset of rigidity and clonic muscular movements, which might be regarded merely as evidence of light anæsthesia. Abdominal rigidity had long been known as possibly due to anoxæmia, and it could be abolished by oxygen. During the third stage of anæsthesia, when all the other signs pointed to deep anæsthesia being present, clonic movements might occur, such as piano-playing movements of the fingers and hands, accompanied by jerky adductor movements of the arms, and irregular movements of the shoulders. These athetotic movements were of great importance, as they were due to lack of oxygen, and were therefore more common under chloroform or its mixtures than under ether.

ANÆSTHESIA AT THE LAHEY CLINIC, BOSTON.

" We have never considered the value of surgical organization in our clinic without being at once impressed with the value and need of the trained and experienced anæsthetist who devotes his thought and interest solely to this field. We have endeavoured to assign to the anæsthetist the greatest possible degree of responsibility. We believe that although the field of the administration of anæsthesia has become so broad that it requires the entire time of a person to follow it and make himself conversant with the variety of methods, there are great responsibilities outside this realm of the department. We have maintained that the decision as to the type of anæsthesia should be largely decided by the anæsthetist, only after a conference with the surgeon who is familiar with the extent and magnitude of the contemplated operation, the necessity of entirely completing it, or the possibility of modifying it to fit the possible limitations of the method of anæsthesia.

Beyond this, however, we have firm convictions that an important function of the anæsthetist is to follow closely the general condition of the patient, particularly the bad risk, to assist materially in determining immediately before the patient is operated on, while on the table in the condition under which he or she must endure the procedure, whether or not a complete surgical procedure may be undertaken, or a lesser one instituted. We have to-day such a variety of preliminary procedures that it is often the anæsthetist's function in bad risk cases to advise us as to the necessity of selecting one to apply to the person rating below the average risk. This decision we have often found to be the deciding factor as to success or failure in the bad risk case. We insist that the anæsthetist observe and note on his record the degree of post-operative reaction, shock, etc., in order that he may develop a background of experience on which to draw for future decisions in advising the limitation of contemplated procedures. We insist that he acquire an approximate estimate of the time that given surgical procedures require in our hands; that he become familiar with the different stages of the operative procedures, so that he may roughly estimate the time still necessary to complete them, and that he make complete use of all methods of aid in determining the immediate condition and prophesying the probable later effect as the operation continues, such as blood pressure, pulse pressure, colour, breathing, course and difficulties of the anæsthesia. Further, we insist that he shall be in such contact with the patient pre-operatively and post-operatively that he shall represent an individual and a personality to the patient, not a machine-like adjunct to the surgical procedure, which induces unconsciousness in the patient and then

disappears from the horizon. In addition to this, he must follow closely the developments in anæsthesia, assimilating gradually and cautiously those which will be of service and diminish the danger in the bad risk. He must keep accurate records as to outcome, complications and results, so that we may confirm or contradict impressions as to the best methods to employ in the doubtful cases."

DR. FRANK H. LAHEY.

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